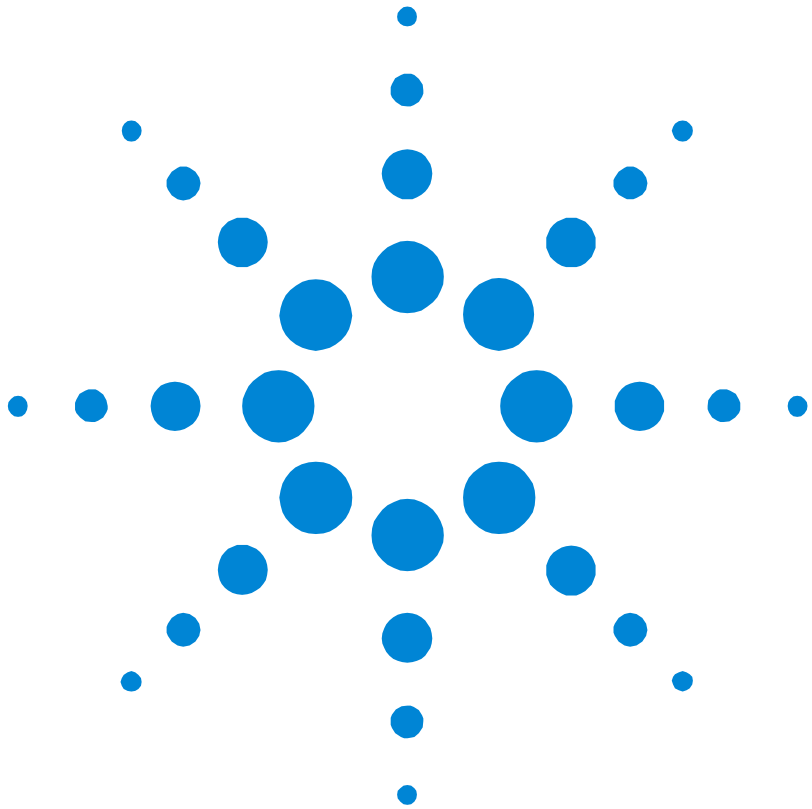

Agilent 81560A, 81561A Variable Optical Attenuator Modules and Agilent 81566A, 81567A Variable Optical Attenuator Modules with Power Control

User's Guide

Agilent Technologies

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Produced to ISO 9001 international quality system standard as part of our objective of continually increasing customer satisfaction through improved process control.

First Edition

81560-90A11

First Edition:
81560-90A11: November 2001

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies Inc. assumes no liability for the customer's failure to comply with these requirements.

Before operation, review the instrument and manual, including the red safety page, for safety markings and instructions. You must follow these to ensure safe operation and to maintain the instrument in safe condition.

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice or the like, which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

Safety Symbols

The apparatus will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect the apparatus against damage.

Hazardous laser radiation.

Initial Inspection

Inspect the shipping container for damage. If there is damage to the container or cushioning, keep them until you have checked the contents of the shipment for completeness and verified the instrument both mechanically and electrically.

The Performance Tests give procedures for checking the operation of the instrument. If the contents are incomplete, mechanical damage or defect is apparent, or if an instrument does not pass the operator's checks, notify the nearest Agilent Technologies Sales/Service Office.

WARNING

To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, etc.).

WARNING

You *MUST* return instruments with malfunctioning laser modules to an Agilent Technologies Sales/Service Center for repair and calibration.

Line Power Requirements

The Agilent 81560A, 81561A Variable Optical Attenuator modules and Agilent 81566A, 81567A Variable Optical Attenuator modules with Power Control operate when installed in the Agilent 8163A and B Lightwave Multimeters, the Agilent 8164A and B Lightwave Measurement Systems, or the Agilent 8166A and B Lightwave Multichannel Systems.

Within this User's Guide, these instruments are collectively referred to as 'mainframes'.

Operating Environment

The safety information in your mainframe's User's Guide summarizes the operating ranges for the Agilent 81560A, 81561A Variable Optical Attenuator modules and Agilent 81566A, 81567A Variable Optical Attenuator modules with Power Control. In order for these modules to meet specifications, the operating environment must be within the limits specified for your mainframe.

Storage and Shipment

Agilent 81560A, 81561A Variable Optical Attenuator modules and Agilent 81566A, 81567A Variable Optical Attenuator modules with Power Control can be stored or shipped at temperatures between

–40°C and +70°C.

Protect the module from temperature extremes that may cause condensation within it.

Firmware Prerequisites

For Agilent 8156x modules with a particular firmware revision to operate correctly, your Agilent 8163A/B, 8164A/B, or 8166A/B mainframe must have a V3.5, or later, firmware revision installed.

Firmware files are provided on the OCT Support CD-ROM supplied with the instrument, and the latest firmware revisions can also be downloaded via www.Agilent.com/comms/comp-test

The firmware for A and B versions of our mainframes is not binary compatible. Make sure you select the appropriate firmware for your instrument.

NOTE

- Updating mainframe firmware does not require you to update the firmware in every hosted module. New revisions of mainframe firmware are backwards compatible with older module firmware.
- You may find it advantageous to update module firmware. To help you determine which module firmware to update, a readme file is provided with the firmware file detailing its revision history.
- If the serial number of your HP 8164A Lightwave Measurement System is DExxxxx339 or below, problems with writing files to the floppy disk drive may occur in rare cases. If this is the case, please contact your nearest Agilent Technologies Sales / Service Office.

Checking your Current Firmware Revision

8163A/B Lightwave Multimeter, 8164A/B Lightwave Measurement System, or 8166A/B Lightwave Multichannel System

To check your 8163A/B Lightwave Multimeter, 8164A/B Lightwave Measurement System, or 8166A/B Lightwave Multichannel System's firmware revision:

1 Press the Config hardkey.

2 Move to the <About Mainframe> menu option and press Enter.

3 The manufacturer, part number, instrument number, and firmware revision are listed. If the firmware revision number is less than V3.5, follow the Update Procedure described in the readme.txt on the root directory of this compact disk to install the newest firmware revision for your mainframe.

8156x Series Modules

To check an 8156x series module's firmware revision:

1 Press the Config hardkey.

2 Move to the <About Modules> menu option and press Enter. You see a box displaying the slots that have a module installed.

3 Move to the appropriate slot using the cursor key and press Enter.

4 The part number, module number, and firmware revision of the chosen module are displayed. If the firmware revision number is less than V3.5, follow the Update Procedure described in readme.txt on the root directory of this compact disk to install the newest firmware revision.

The Structure of this Manual

This manual is divided into two parts:

- Getting Started
  This section gives an introduction to the attenuator modules and aims to make these modules familiar to you:
  - *"Getting Started with Attenuator Modules" on page 15*.
- Additional Information
  This is supporting information of a non-operational nature, concerning accessories, specifications, and performance tests:
  - *"Accessories" on page 23*,
  - *"Specifications" on page 29*, and
  - *"Performance Tests" on page 39*.

Conventions used in this manual

- Hardkeys are indicated by italics, for example, *Config*, or *Channel*.
- Softkeys are indicated by normal text enclosed in square brackets, for example, [Zoom] or [Cancel].
- Parameters are indicated by italics enclosed by square brackets, for example, [*Range Mode*], or [*MinMax Mode*].
- Menu items are indicated by italics enclosed in brackets, for example, <*MinMax*>, or <*Continuous*>.

Table of Contents

Safety Summary 3
Safety Symbols 3
Initial Inspection 3
Line Power Requirements 4
Operating Environment 4
Storage and Shipment 4
Firmware Prerequisites 5
Checking your Current Firmware Revision 5
8163A/B Lightwave Multimeter, 8164A/B Lightwave Measurement System, or 8166A/B Lightwave Multichannel System 5
8156x Series Modules 6
The Structure of this Manual 7
Conventions used in this manual 7

Getting Started with Attenuator Modules 15

What is an Attenuator? 17
Installation 17
Variable Optical Attenuator Front Panels 18
Front Panel Controls and Indicators 18
Variable Optical Attenuator Front Panels 19
Front Panel Controls and Indicators 19
Typical Use Models 20
Optical Output 22
Angled and Straight Contact Connectors 22

Accessories 23

Modules and Options 25
Modules 25
User's Guides 26
Connector Interfaces and Other Accessories 27
81560A and 81566A Variable Optical Attenuator Modules 27
81561A and 81567 Variable Optical Attenuator Modules 28

Specifications 29

Definition of Terms 31

- Accuracy (Uncertainty) 31
- Attenuation 31
- Attenuation Setting (where applicable) 32
- Attenuation Range 32
- Correction (of Attenuation) 32
- Insertion Loss 33
- Maximum Input Power 33
- Operating Temperature 33
- Polarization Dependent Loss (PDL) 33
- Power setting (where applicable) 33
- Reference Connector 33
- Relative Power Meter Uncertainty (where applicable) 34
- Repeatability 35
- Resolution 35
- Return Loss 35
- Settling Time 35
- Shutter Isolation 36
- Total Loss 36
- Wavelength Range 36

Specifications 37

Performance Tests 39

Required Test Equipment 41

- Test Record 42
- Test Failure 42
- Instrument Specification 42

Performance Test Instructions 43

- Insertion Loss Test 44
- Accuracy Test 45
- Repeatability Test 46
- Power Setting Repeatability Test 46
- Return Loss Test 47
- Polarization Dependent Loss (PDL) Test - Scanning method 49
- Polarization Dependent Loss (PDL) Test - Mueller Method 50
- Relative Power Meter Uncertainty Test 54

Test Record 57

Test Equipment Used 58
Insertion Loss Test 59
Attenuation Accuracy Test 59
Attenuation Repeatability Test 60
Power Setting Repeatability Test 60
Return Loss Test 61
Polarization Dependent Loss Test - Scanning Method (11896A) 62
Polarization Dependent Loss Test - Mueller Method (8169A) 62
Relative Power Meter Uncertainty Test 64

Cleaning Information 65

Safety Precautions 67
Why is it important to clean optical devices? 67
What do I need for proper cleaning? 68
Standard Cleaning Equipment 68
Dust and shutter caps 68
Isopropyl alcohol 69
Cotton swabs 69
Soft tissues 70
Pipe cleaner 70
Compressed air 70
Additional Cleaning Equipment 71
Microscope with a magnification range about 50X up to 300X 71
Ultrasonic bath 71
Warm water and liquid soap 72
Premoistened cleaning wipes 72
Polymer film 72
Infrared Sensor Card 72
Preserving Connectors 73
Cleaning Instrument Housings 73
Which Cleaning Procedure should I use ? 74
How to clean connectors 74
How to clean connector adapters 75
How to clean connector interfaces 76
How to clean bare fiber adapters 77
How to clean lenses 78
How to clean instruments with a fixed connector interface 78
How to clean instruments with an optical glass plate 79

How to clean instruments with a physical contact interface 79
How to clean instruments with a recessed lens interface 80
How to clean optical devices which are sensitive to mechanical stress and pressure 81
How to clean metal filters or attenuator gratings 82
Additional Cleaning Information 83
How to clean bare fiber ends 83
How to clean large area lenses and mirrors 83
Other Cleaning Hints 85

List of Figures

Figure 1	Agilent 81566A/81567A Optical Attenuators with Power Control	17
Figure 2	Agilent 81560A Attenuator with Straight Connector	18
Figure 3	Agilent 81561A Attenuator with Angled Connector	18
Figure 4	Agilent 81566A Attenuator with Power Control and Straight Connector	19
Figure 5	Agilent 81567A Attentuator with Power Control and Angled Connector	19
Figure 6	Angled and Straight Contact Connector Symbols	22
Figure 7	Mainframes, Variable Optical Attenuator Modules, and Options	25
Figure 8	Straight Contact Connectors	27
Figure 9	Angled Contact Connectors	28
Figure 10	Insertion Loss Reference Setup	44
Figure 11	Insertion Loss Test Setup	45
Figure 12	Return Loss Reference Setup	47
Figure 13	Return Loss Test Setup	48
Figure 14	PDL Test Setup - Scanning Method	49
Figure 15	PDL Reference Setup	50
Figure 16	PDL Test Setup - Mueller Method	52
Figure 17	Relative Power Meter Uncertainty Setup	54

List of Figures

Getting Started with Attenuator Modules

This chapter describes the Agilent Variable Optical Attenuator modules and Agilent Variable Optical Attenuator modules with Power Control.

What is an Attenuator?

Agilent 8156xA Variable Optical Attenuators attenuate and control the optical power of light in single-mode optical fibers. They allow you to set the attenuation factor and/or power level manually, or via the host instrument's GPIB interface.

Agilent 81566A and 81567A attenuators include power control functionality that allows you to set the output power level of the attenuator. When power control mode is enabled, the module automatically corrects for power changes at the input so that the output power level set by the user is maintained. See Figure 1 on page 17.

Installation

Agilent 8156xA Variable Optical Attenuators are front-loadable modules for the Agilent 8163A/B Lightwave Multimeter, 8164A/B Lightwave Measurement System, and 8166A/B Lightwave Multichannel System, collectively referred to as 'mainframes'.

An Agilent 81560A or 81561A module occupies one slot, while an Agilent 81566A or 81567A module occupies two slots.

For a description of how to install your module, refer to "How to Fit and Remove Modules" in the Installation and Maintenance chapter of your mainframe's User's Guide.

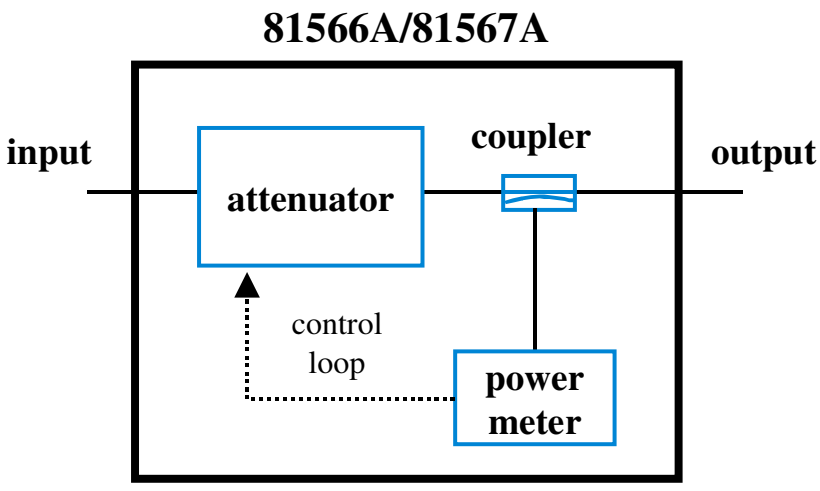


Figure 1 Agilent 81566A/81567A Optical Attenuators with Power Control

Variable Optical Attenuator Front Panels

Agilent 81560A

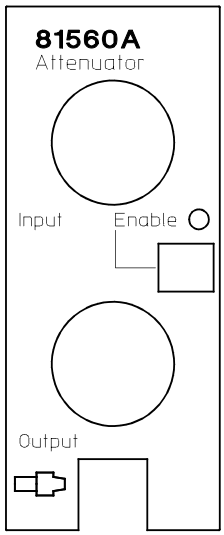


Figure 2 Agilent 81560A Attenuator with Straight Connector

Agilent 81561A

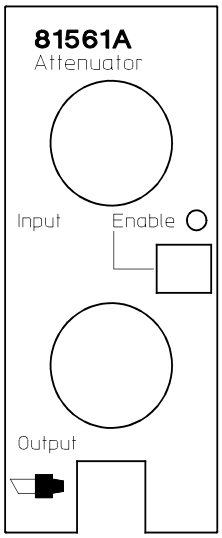


Figure 3 Agilent 81561A Attenuator with Angled Connector

Front Panel Controls and Indicators

The front panel contains a push button to switch the shutter open/closed, and a LED that indicates the state of the shutter. If the shutter is “open”, the LED shows “enable”, and light can pass through the instrument.

Variable Optical Attenuator Front Panels

Agilent 81566A

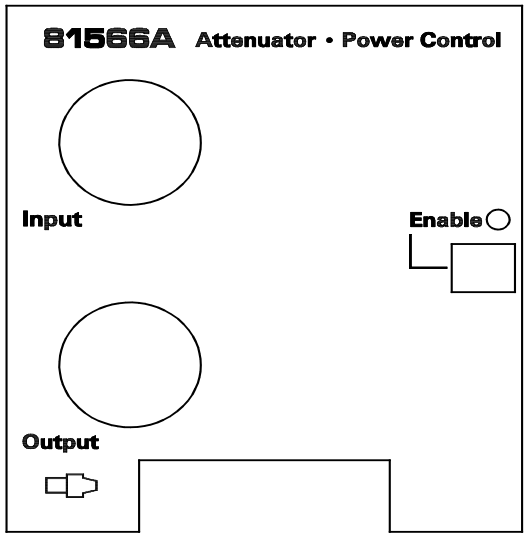


Figure 4 Agilent 81566A Attenuator with Power Control and Straight Connector

Agilent 81567A

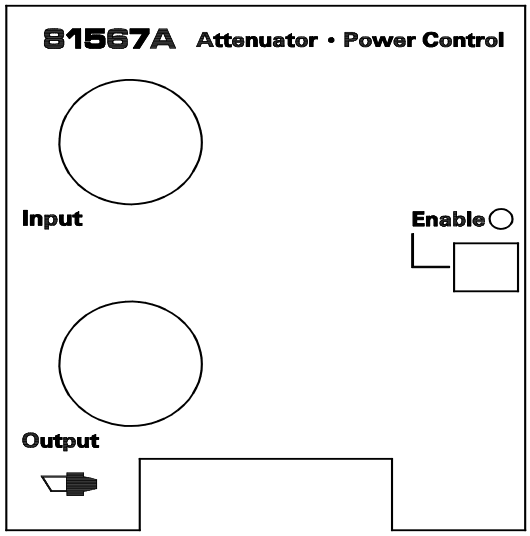


Figure 5 Agilent 81567A Attentuator with Power Control and Angled Connector

Front Panel Controls and Indicators

The front panel contains a push button to switch the shutter open/closed, and a LED that indicates the state of the shutter. If the shutter is “open”, the LED shows “enable”, and light can pass through the instrument.

Typical Use Models

Brief description

Agilent's 8156xA Variable Optical Attenuators are instruments that attenuate and control the optical power level of light in single mode optical fibers. As plug-in modules for Agilent's Lightwave Multichannel platform (8163A/B, 8164A/B, 8166A/B) they allow you to set the attenuation factor and/or power level manually, or remotely via a common computer interface. Their high accuracy combined with their flexibility make them ideal as test and measurement equipment for the modern telecommunication industry.

Modular Design for Multichannel Platform

Agilent's 8156xA variable optical attenuators are a family of plug-in modules for Agilent's Lightwave Multichannel Platform 8163A/B, 8164A/B and 8166A/B. The attenuator modules 81560A and 81561A occupy one slot, while modules 81566A and 81567A occupy two slots. The Agilent 8166A/B Lightwave Multichannel System with its 17 slots can host up to 17 single slot modules (such as the 81560A and 81561A attenuators) or up to 8 dual slot modules, (such as the 81566A and 81567A attenuators).

Variable Optical Attenuators

Agilent's 81560A and 81561A are small and cost effective attenuator modules with high resolution and low insertion loss. Various calibration features allow you to set a reference power so that both the attenuation and the power level, relative to the reference power, can be set and displayed in the user interface. An integrated shutter can be used for protection purposes or to simulate channel drops.

Attenuators with Power Control

Agilent's 81566A and 81567A attenuators feature power control functionality that allows you to set the output power level of the attenuator. The attenuator module firmware uses the feedback signal from a photo diode after a monitor coupler, both integrated in the module, to set the desired power level at the output of the module. When the power control mode is enabled, the module automatically corrects power changes at the input to maintain the output level set by the user. After an initial calibration for the uncertainties at connector interfaces, absolute power levels can be set with high accuracy. The absolute accuracy of these power levels depends on the accuracy of the reference powermeter used for calibration.

Calibration Processes

Comprehensive offset functionality in the firmware enhances the calibration of the optical path in various test set-ups. There is an offset for the attenuation factor, and an independent offset for the output power level, to calibrate for losses due to the patch cords and connectors. Additionally, wavelength and offset value pairs can be stored in a table to compensate for wavelength dependent effects in the optical path of the set-up. This allows you to set the optical power level at your Device Under Test.

Calibration is even easier and more convenient if the reference powermeter and the attenuator are hosted by the same mainframe: All power related offsets can be determined by a firmware function that reads a value from the reference powermeter. The difference between the power value read by the reference powermeter and the actual value of the attenuator is automatically stored as the offset.

Optical Output

Angled and Straight Contact Connectors

Angled contact connectors are available for Agilent Variable Optical Attenuator modules and Agilent Variable Optical Attenuator modules with Power Control. The inclusion of an angled contact connector is not optionable, and depends on the module part number.

Angled contact connectors help you to control return loss, since reflected light tends to reflect into the cladding, reducing the amount of light that reflects back to the source.

CAUTION If the contact connector on your instrument is angled, you can only use cables with angled connectors with the instrument.

Figure 6 Angled and Straight Contact Connector Symbols

Figure 6 shows the symbols that tell you whether the contact connector of your attenuator module is angled or straight. The angled contact connector symbol is colored green.

You should connect straight contact fiber end connectors with neutral sleeves to straight contact connectors and connect angled contact fiber end connectors with green sleeves to angled contact connectors.

NOTE You cannot connect angled non-contact fiber end connectors with orange sleeves directly to the instrument.

See *"Accessories" on page 23* for further details on connector interfaces and accessories.

Accessories

The Agilent 81560A, 81561A Variable Optical Attenuator modules and Agilent 81566A, 81567A Variable Optical Attenuator modules with Power Control are available in various configurations for the best possible match to the most common applications.

This chapter provides information on the available options and accessories.

Modules and Options

Figure 7 shows all the options that are available for Agilent 81560A, 81561A Variable Optical Attenuator modules and Agilent 81566A, 81567A Variable Optical Attenuator modules with Power Control, and the instruments that support these modules.

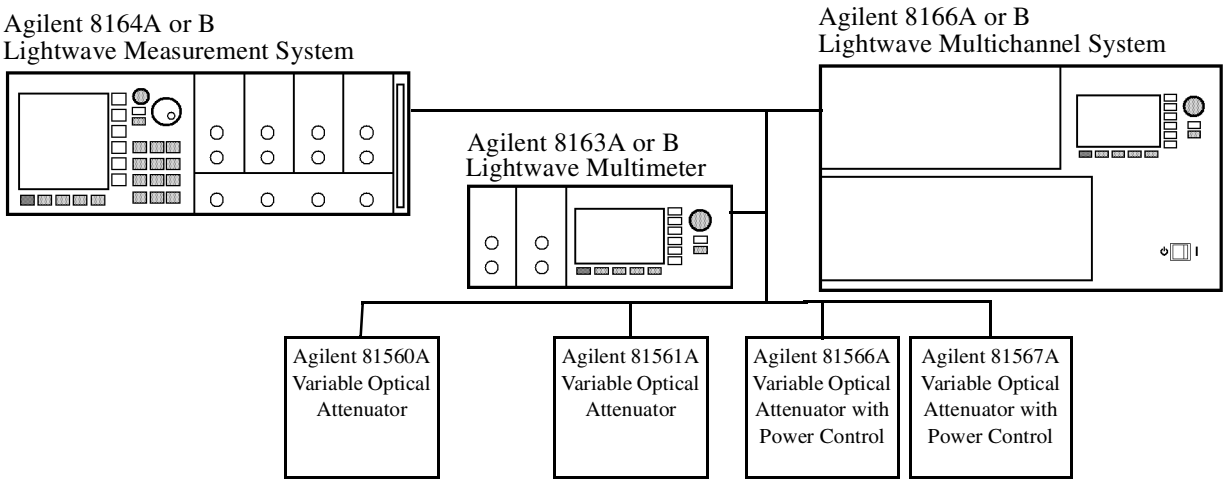


Figure 7 Mainframes, Variable Optical Attenuator Modules, and Options

Modules

Agilent 81560A, 81561A Variable Optical Attenuator modules and Agilent 81566A, 81567A Variable Optical Attenuator modules with Power Control can be hosted by:

- Agilent 8163A and Agilent 8163B Lightwave Multimeters,
- Agilent 8164A and Agilent 8164B Lightwave Measurement Systems,
- Agilent 8166A and Agilent 8166B Lightwave Multichannel Systems.

Variable Optical Attenuator Modules	
Model No.	**Description**
Agilent 81560A	Variable Optical Attenuator with Straight Contact Connector
Agilent 81561A	Variable Optical Attenuator with Angled Contact Connector
Agilent 81566A	Variable Optical Attenuator with Power Control and Straight Contact Connector
Agilent 81567A	Variable Optical Attenuator with Power Control and Angled Contact Connector

User's Guides

User's Guides	
Description	**Part No.**
Agilent 81560A, 81561A Variable Optical Attenuator modules and Agilent 81566A, 81567A Variable Optical Attenuator modules with Power Control User's Guide (English)	81560-90A11
Agilent 81560A, 81561A Variable Optical Attenuator modules and Agilent 81566A, 81567A Variable Optical Attenuator modules with Power Control User's Guide (Traditional Chinese - Taiwan)	81560-97A11
Agilent 81560A, 81561A Variable Optical Attenuator modules and Agilent 81566A, 81567A Variable Optical Attenuator modules with Power Control User's Guide (Korean)	81560-98A11
Agilent 81560A, 81561A Variable Optical Attenuator modules and Agilent 81566A, 81567A Variable Optical Attenuator modules with Power Control User's Guide (Simplified Chinese - China)	81560-96A11
Agilent 81560A, 81561A Variable Optical Attenuator modules and Agilent 81566A, 81567A Variable Optical Attenuator modules with Power Control User's Guide (French)	81560-92A11
Agilent 81560A, 81561A Variable Optical Attenuator modules and Agilent 81566A, 81567A Variable Optical Attenuator modules with Power Control User's Guide (Japanese)	81560-95A11
Agilent 8163A/B Lightwave Multimeter, Agilent 8164A/B Lightwave Measurement System, & Agilent 8166A/B Lightwave Multichannel System User's Guide	08164-90B13
Agilent 8163A/B Lightwave Multimeter, Agilent 8164A/B Lightwave Measurement System, & Agilent 8166A/B Lightwave Multichannel System Programming Guide	08164-90B62

Connector Interfaces and Other Accessories

81560A and 81566A Variable Optical Attenuator Modules

If you want to use straight connectors (such as FC/PC, Diamond HMS-10, DIN, Biconic, SC, ST or D4) to connect to the instrument, you must do the following:

1 Attach your connector interface to the interface adapter.

See Table 1 for a list of the available connector interfaces.

2 Connect your cable (see Figure 8).

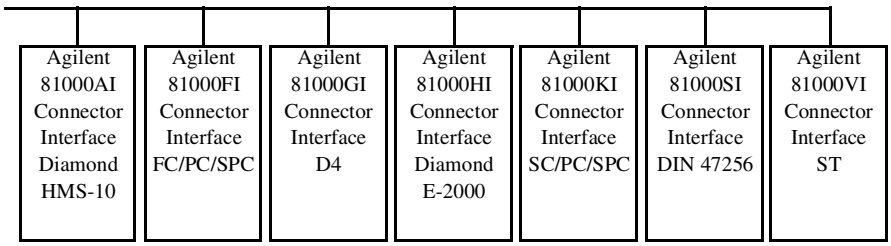

Agilent 81000AI Connector Interface Diamond HMS-10
Agilent 81000FI Connector Interface FC/PC/SPC
Agilent 81000GI Connector Interface D4
Agilent 81000HI Connector Interface Diamond E-2000
Agilent 81000KI Connector Interface SC/PC/SPC
Agilent 81000SI Connector Interface DIN 47256
Agilent 81000VI Connector Interface ST

Figure 8 Straight Contact Connectors

Table 1 Straight Contact Connectors

Description	Model No.
D4	Agilent 81000 GI
Diamond HMS-10	Agilent 81000 AI
DIN 47256/4106	Agilent 81000 SI
FC / PC / SPC	Agilent 81000 FI
SC / PC / SPC	Agilent 81000 KI
ST	Agilent 81000 VI
Diamond E-2000	Agilent 81000 HI

81561A and 81567 Variable Optical Attenuator Modules

If you want to use angled connectors (such as FC/APC, Diamond HRL-10, or SC/APC) to connect to the instrument, you must do the following:

1 Attach your connector interface to the interface adapter.

See Table 2 for a list of the available connector interfaces.

2 Connect your cable (see Figure 9).

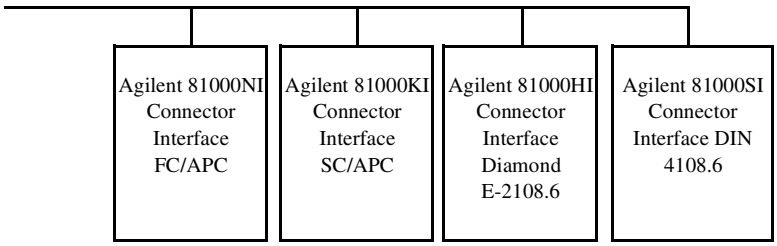

Agilent 81000NI Connector Interface FC/APC
Agilent 81000KI Connector Interface SC/APC
Agilent 81000HI Connector Interface Diamond E-2108.6
Agilent 81000SI Connector Interface DIN 4108.6

Figure 9 Angled Contact Connectors

Table 2 Angled Contact Connectors

Description	Model No.
DIN 4108.6/47256/4108	Agilent 81000 SI
FC / APC	Agilent 81000 NI
SC / APC	Agilent 81000 KI
Diamond E-2108.6	Agilent 81000 HI

Specifications

The Agilent 81560A, 81561A Variable Optical Attenuator modules and Agilent 81566A, 81567A Variable Optical Attenuator modules with Power Control are produced to the ISO 9001 international quality system standard as part of Agilent Technologies' commitment to continually increasing customer satisfaction through improved quality control.

Specifications describe the modules' warranted performance. Supplementary performance characteristics describe the modules non-warranted typical performance.

Because of the modular nature of the instrument, these performance specifications apply to these modules rather than the mainframe unit.

Definition of Terms

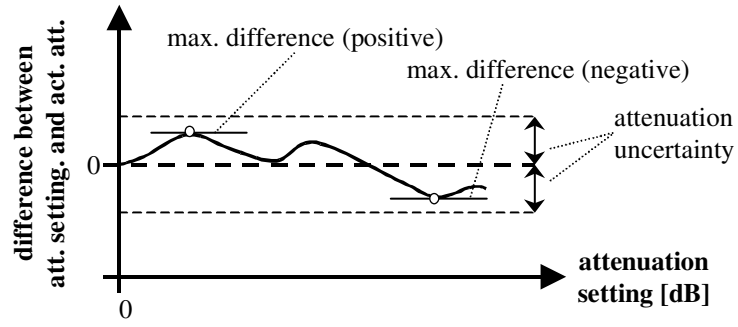
This section defines terms that are used both in this chapter and *"Performance Tests" on page 39*.

Generally, all specifications apply for the given environmental conditions and after warmup time.

Measurement principles are indicated. Alternative measurement principles of equal value are also acceptable.

Accuracy (Uncertainty)

The maximum possible difference (in dB) between attenuation setting and actual attenuation. This specification is equivalent to the linearity of attenuation

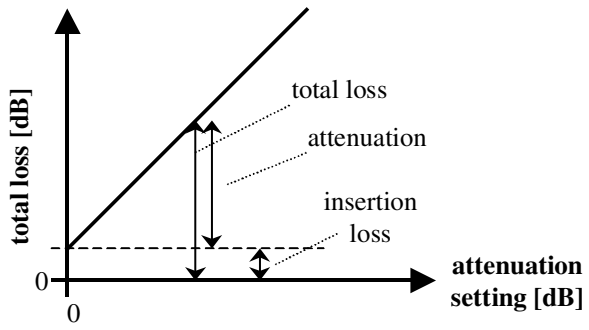


Conditions: Attenuator set to the wavelength of the source, constant polarization state, constant temperature, excluding wavelengths of water absorption lines. Other conditions as specified.

Measurement: With Fabry-Pérot type laser source of applicable wavelength and optical power meter.

Attenuation

Difference (in dB) between total loss and total loss at 0 dB setting (insertion loss).



NOTE For a displayed attenuation of 0 dB the actual attenuation is 0 dB per definition.

Attenuation Setting (where applicable)

When changing the displayed attenuation, this module behaves like a pure attenuator.

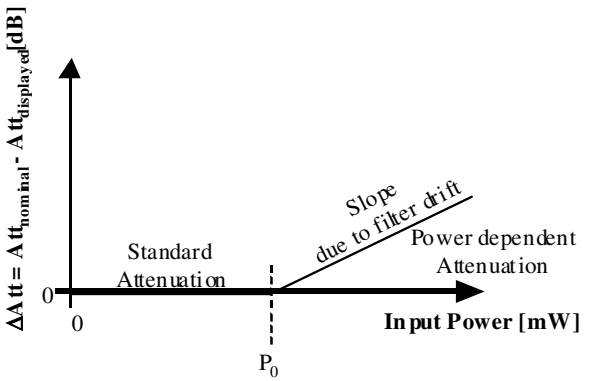
NOTE Alternatively, the attenuator can be operated in power setting.

Attenuation Range

Range of displayed attenuation for which the specifications apply.

Correction (of Attenuation)

The filter has a power-dependent attenuation, because of warm-effects. The displayed attenuation is valid up to a specified power P0. For higher power levels, the nominal attenuation should be calculated with the given formula. In this case the specified accuracy is applicable within the entire specified power range.



Measurement: with EDFA to apply the necessary input power, TLS and Optical Power Meter to test the wavelength dependence

Insertion Loss

Total loss at an attenuation setting of 0 dB.

Conditions: as specified, with reference connectors

Measurement: with Fabry-Pérot Laser Source.

Maximum Input Power

The maximum input power level that can be applied to the attenuator without permanent change of its characteristics.

Operating Temperature

The range of ambient temperatures of the mainframe hosting the attenuator module for which the temperatures apply.

Polarization Dependent Loss (PDL)

The dependence of the total loss on the input polarization state, expressed as the difference (in dB) between the highest and the lowest total loss (peak to peak).

Conditions: Fabry-Pérot type laser source with variable polarization state and polarization-independent power, generation of all polarization states (covering the entire Poincaré sphere), jumper cables with reference connectors and applicable wavelength.

Measurement: either with fiber-loop type polarization scrambler using polarization scanning method or waveplate-type polarization controller using Mueller method.

Power setting (where applicable)

When changing the displayed power, the attenuation will be controlled by the integrated power meter to set the output power to the displayed power.

Reference Connector

Diamond® HMS-10 connector with perfect optical and mechanical quality. Depending on the case, straight or angled.

Relative Power Meter Uncertainty (where applicable)

When changing the output power of attenuator, the relative power meter uncertainty is the maximum error of the displayed output power ratio to the actual output power ratio. This uncertainty is caused by the internal power meter's nonlinearity and noise and by errors in the sensing hardware, expressed as ± half the span of all possible errors with an offset due to the noise level of the power meter. Symbol RU.

Conditions: at constant polarization state, with random reference power level taken at an arbitrary displayed attenuation, input power and output power limitations as specified. This doesn't include the accuracy of attenuator (nonlinearity).

Measurement: The nonlinearity is calculated using the displayed power ratio D2 / D1 and the corresponding actual power ratio P2/P1:

$$N_{dB}(1,2) = 10 \cdot \log\left(\frac{D_2 / D_1}{P_2 / P_1}\right)$$

The relative power meter uncertainty is then calculated using:

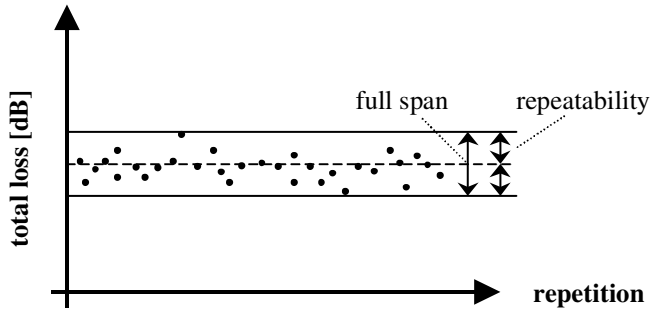
$$RU_{dB} = \pm\frac{\max\left|N_{dB}(1,2)\right|}{2}$$

RU is then expressed in dB and the offset is expressed in pW.

NOTE Absolute power meter accuracy attainable with the help of an external power meter.

Repeatability

The uncertainty in reproducing the total loss after randomly changing and re-setting the attenuation. The repeatability is ± half the span between the maximum and the minimum total loss, expressed in dB.



Conditions: Uninterrupted line voltage, constant temperature, constant humidity, constant wavelength, constant input power level, and constant polarization state.

Measurement: with Fabry-Pérot type laser source (center wavelength as specified ± 15nm) and optical power meter.

Resolution

The minimum addressable and displayable attenuation steps over the whole attenuation range.

Return Loss

Minimum ratio between incident power and reflected power, expressed in dB. Applicable to both attenuator ports, with the respective second port terminated (zero reflectance).

Conditions: jumper cables with reference connectors on both attenuator ports.

Measurement: with return loss meter using Fabry-Pérot type laser source of applicable wavelength.

NOTE Measurement result includes attenuator-internal reflections, reflections from both attenuator ports and reflection from shutter (in case of closed shutter).

Settling Time

Maximum time needed to change the attenuation by a specified step, from the beginning till the end of the change.

Measurement: With optical oscilloscope or transcient recorder.

NOTE Settling time excludes the time needed for the interpretation of the command and for the internal communication between the mainframe and the attenuator module.

Shutter Isolation

Ratio between transmitted powers with open and with closed shutter, at an attenuator setting of 0 dB, expressed in dB.

Total Loss

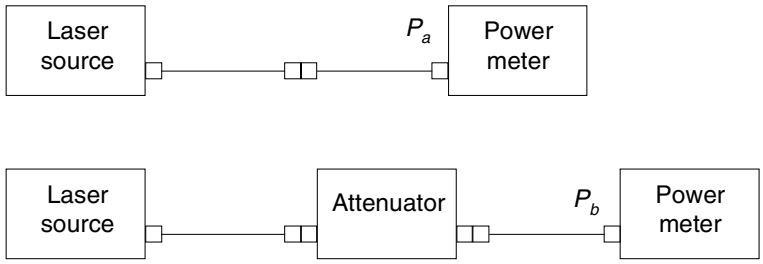
Change of power level after inserting the attenuator between two connectorized patchcords, at an arbitrary attenuation setting, expressed in dB. It can be calculated from:

$$A_{TL}[\text{dB}] = 10\log\frac{P_a}{P_b} = P_a[\text{dBm}] - P_b[\text{dBm}]$$

where:

Pa=power measured at the end of the two patchcords.

Pb=power measured after the insertion of the attenuator.



Conditions: Jumper cables with reference connectors on both attenuator ports.

Measurement: With laser source or LED and optical power meter.

NOTE Total loss includes the loss from one additional connection.

Wavelength Range

Usable wavelength range.

Specifications

Variable Optical Attenuator Modules		
	Agilent 81560A	**Agilent 81561A**
Connectivity[1]	straight connector	angled connector
Fiber type	9/125 µm SMF28	9/125 µm SMF28
Wavelength range	1200-1700 nm	1200-1700 nm
Attentuation range	0-60 dB	0-60 dB
Resolution	0.001 dB	0.001 dB
Repeatability[2]	±0.01 dB	±0.01 dB
Accuracy (uncertainty)[3]	±0.1 dB[4]	±0.1 dB[4]
Settling time[5]	typ. <100 ms	typ. <100 ms
Insertion loss[6]	typ. 1.7 dB	typ. 1.7 dB
Polarization dependent loss[6,7]	< 0.05 dBpp	< 0.05 dBpp
Return loss[6]	typ. > 45 dB	typ. > 60 dB
Maximum input power[8]	+ 23 dBm	+ 23 dBm
Shutter isolation	typ. > 100 dB	typ. > 100 dB
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.8" x 1.3" x 13.2")	
Weight	0.9 kg	
Recommended recalibration period	2 years	
Operating temperature	10 °C - 45 °C	
Humidity	Non-condensing	
Warm-up time	30 Min.	

[1] For Agilent's versatile optical connector interfaces

[2] At constant wavelength, temperature, SOP

[3] SOP constant; temperature constant and within 23 °C ± 5 °C; for input power ≤ +10 dBm $attenuation_{nominal} = attenuation_{display}$

for input power > 10 mW and 1500 nm < λ < 1600 nm apply correction: $attenuation_{nominal} = attenuation_{display}(1+0.0002 \cdot (P[mW] - 10) \cdot (\lambda[\mu m] - 1.5))$

[4] For λ= 1550 nm ± 15 nm and for input power ≤ +10 dBm; typically ± 0.1 dB for 1250 nm < λ < 1650 nm

[5] For stepsize < 1 dB; for full range typically < 6 s

[6] For λ = 1550 nm ± 15 nm with reference connectors

[7] Temperature constant and within 23 °C ± 5 °C

[8] Exposure time < 2h

Variable Optical Attenuator Modules with Power Control				
	Agilent 81566A		**Agilent 81567A**	
Connectivity[1]	straight connector		angled connector	
Fiber type	9/125 µm SMF28		9/125 µm SMF28	
Wavelength range	1250-1650 nm		1250-1650 nm	
Attentuation range	0-60 dB		0-60 dB	
Resolution	0.001 dB		0.001 dB	
	Attenuation Setting	**Power Setting**	**Attenuation Setting**	**Power Setting**
Repeatability[2]	±0.01 dB	±0.01 dB[3]	±0.01 dB	±0.01 dB[3]
Accuracy (uncertainty)[4]	±0.1 dB[5]		±0.1 dB[5]	
Settling time[6]	typ. < 100 ms	typ. < 300 ms	typ. <100 ms	typ. <300 ms
Relative power meter uncertainty[7]	± 0.03 dB ± 20 pW		± 0.03 dB ± 20 pW	
Insertion loss[8]	typ. 2.2 dB		typ. 2.2 dB	
Polarization dependent loss[8,9]	< 0.08 dBpp		< 0.08 dBpp	
Return loss[8]	typ. > 45 dB		typ. > 60 dB	
Maximum input power[10]	+ 23 dBm		+ 23 dBm	
Shutter isolation	typ. > 100 dB		typ. > 100 dB	
Dimensions (H x W x D)	75 mm x 64 mm x 335 mm (2.8" x 2.6" x 13.2")			
Weight	1.3 kg			
Recommended recalibration period	2 years			
Operating temperature	10 °C - 45 °C			
Humidity	Non-condensing			
Warm-up time	30 min.			

[1] For Agilent's versatile optical connector interfaces

[2] At constant wavelength, temperature, SOP

[3] Output power > - 50 dBm, input power ≤ +17 dBm, for input power > +17 dBm add typically ±0.01 dB

[4] SOP constant; temperature constant and within 23 °C ± 5 °C; for input power ≤ +10 dBm $attenuation_{nominal} = attenuation_{display}$

for input power > 10 mW and 1500 nm < λ < 1600 nm apply correction: $attenuation_{nominal} = attenuation_{display}(1+0.0002 \cdot (P[mW] - 10) \cdot (\lambda[\mu m] - 1.5))$

[5] For λ = 1550 nm ± 15 nm and for input power ≤ +10 dBm; typically ± 0.1 dB for 1250 nm < λ < 1650 nm

[6] For stepsize < 1 dB; for full range typically < 6 s

[7] Wavelength constant; SOP constant; temperature constant and within 23 °C ± 5 °C, output power >-60 dBm, input power ≤ +17 dBm, for input power > +17 dBm add ±0.02 dB

[8] For λ = 1550 nm ± 15 nm with reference connectors

[9] Temperature constant and within 23 °C ± 5 °C

[10] Exposure time < 2h

Performance Tests

The procedures in this section test the optical performance of the Agilent 8156xA Variable Optical Attenuator modules. The complete specifications to which the instrument is tested are given in *"Specifications" on page 29*.

All tests can be performed without access to the interior of the instrument. The performance tests refer specifically to test using an Agilent reference connector.

Required Test Equipment

The equipment required for the Performance Test is listed in Table 3. Any equipment that satisfies the critical specifications of the equipment given in Table 3 may be substituted for the recommended models.

Table 3 Equipment Required

Instrument/ Accessory	Model	81560A	81561A	81566A	81567A	Required Characteristics	Alternative Models
Lightwave Multimeter	Agilent 8163A/B	x	x	x	x	2x (4 slots)	8164A/B
Laser Source Module	Agilent 81654A	x	x	x	x	1550nm	
Power Sensor Module	Agilent 81634B	x	x	x	x		
Interface Module	Agilent 81618A	x	x	x	x		
Optical Head	Agilent 81624B	x	x	x	x	low PDL	
Depolarizing Filter	Agilent 81000DF	x	x	x	x		
HMS-10 Optical Head Adapter	Agilent 81000AA	x	-	x	-		
FC/PC Optical Head Adapter	Agilent 81000FA	-	x	-	x		
Optical Attenuator	Agilent 81561A	-	-	x	x		8156A #201
Return Loss Module	Agilent 81612A	x	x	x	x		
Reference Cable	Agilent 81610CC	x	x	x	x		
Polarization Controller	Agilent 11896A #010	x	x	x	x		8169A #022
Single Mode Fiber	Agilent 81101PC	x	-	x	-		
Single Mode Fiber	Agilent 81113PC	x	x	x	x		
Single Mode Fiber	Agilent 81113SC	-	x	-	x		
Connector Interface HMS-10	Agilent 81000AI	x	-	x	-		
Connector Interface FC/PC	Agilent 81000FI	-	x	-	x		
Connector Interface DIN	Agilent 81000SI	x	x	x	x		
DIN Feedthrough Adapter	1005-0255	-	x	-	x		
FC/PC Feedthrough Adapter	1005-0256	x	-	x	-		

Legend:

x necessary

- not applicable

o optional

Test Record

Results of the performance test may be tabulated in the Test Record provided at the end of the test procedures. It is recommended that you fill out the Test Record and refer to it while doing the test. Since the test limits and setup information are printed on the Test Record for easy reference, the record can also be used as an abbreviated test procedure (if you are already familiar with the test procedures). The Test Record can also be used as a permanent record and may be reproduced without written permission from Agilent Technologies.

Test Failure

If the Agilent 81560/61A/66A/67A Attenuator module fails any performance test, return the instrument to the nearest Agilent Technologies Sales/ Service Office for repair.

Instrument Specification

Specifications are the performance characteristics of the instrument that is certified. These specifications, listed in *"Specifications" on page 29* are the performance standards or limits against which the Agilent 81560A/61A/66A/67A can be tested.

Any changes in the specifications due to manufacturing changes, design, or traceability to the National Institute of Standards and Technology (NIST), will be covered in a manual change supplement, or revised manual. Such specifications supersede any that were previously published.

Performance Test Instructions

The performance tests given in this section includes the Attenuation Repeatability Test. Perform each step in the order given, using the corresponding test equipment.

Operate an Agilent 81566A and 81567A Attenuator module as an attenuator and switch the power control loop off if not otherwise mentioned.

NOTE: Make sure that all optical connections of the test setup given in the procedure are dry and clean. DO NOT USE INDEX MATCHING OIL. Make sure that all optical connectors are undamaged.

For cleaning, use the cleaning instructions given in *"Cleaning Information" on page 65*.

Make sure that all optical cables of the test setup are fixed to the table so that they won't move during measurements.

Movement of the fibers during the test procedures and the quality of optical connectors affect the result of power measurements.

The environmental conditions (temperature and relative humidity) must remain constant during the test.

Insertion Loss Test

Carry out the following Insertion Loss Test at 1550 nm with single mode fibers using the equipment listed in Table 3, “Equipment Required,” on page 41. To adapt for the straight or angled contact versions of the attenuator use the patchcords with appropriate connectors and the adequate connector interfaces.

1 Turn the instruments on and allow the devices to warm up (20..30min).

2 Make sure that all your connectors are clean and undamaged.

3 Connect the equipment as shown in Figure 10.

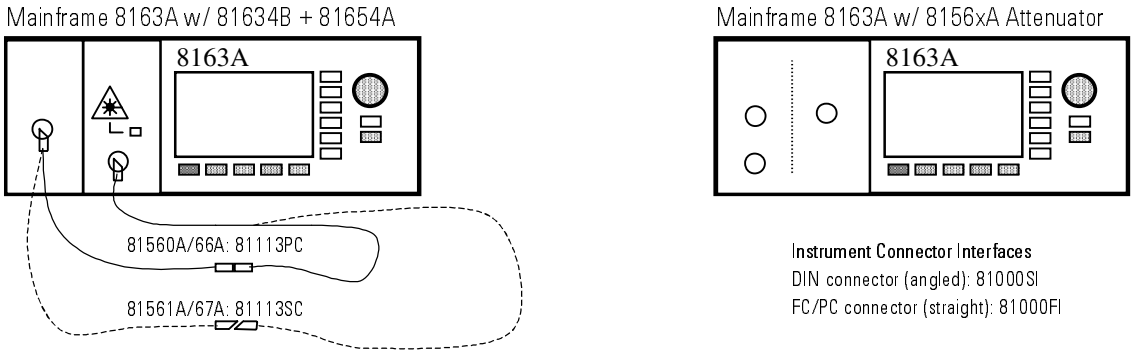


Figure 10 Insertion Loss Reference Setup

4 Set the attenuator and the power meter to the actual wavelength of the laser source.

5 Disable the laser source, zero the power meter and select Autorange. Display [dB].

6 Set the power meter averaging time to 500ms.

7 Enable the laser source and set Display to Reference on the power meter.

8 Connect the equipment as shown in Figure 11.

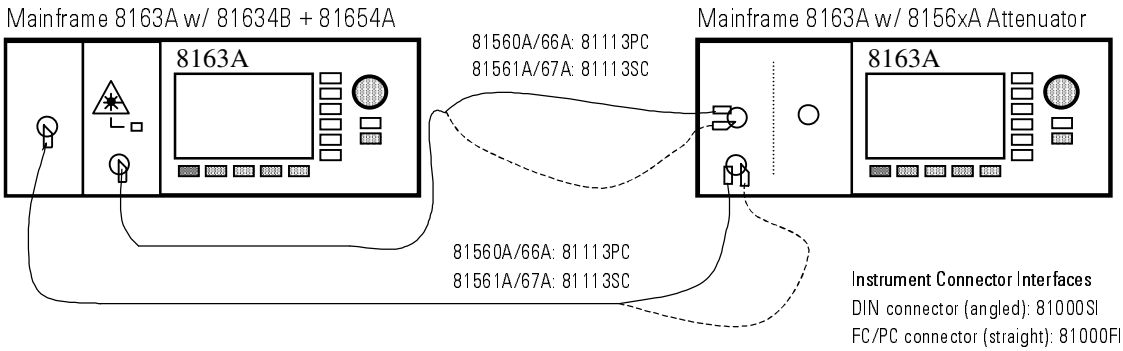


Figure 11 Insertion Loss Test Setup

9 Set attenuation [α] to 0dB and open the shutter.

10 Record the power meter reading (in dB) in the Test record.

Accuracy Test

Use the same equipment and test setup as used in Figure 11.

NOTE: With a laser source with output power < +10dBm it is not necessary to recalculate the real attenuation.

1 Turn the instruments on and allow the devices to warm up (20..30min).

2 Make sure that all your connectors are clean and undamaged.

3 Set the attenuator and the power meter to the actual wavelength of the laser source.

4 Disable the laser source, zero the power meter and select Autorange. Display [dB].

5 Enable the laser source, open the shutter and set attenuation [α] to 0 dB.

6 Set Display to Reference on the power meter.

7 Set the attenuation [α] to the different values listed below and note the power meter reading in the Test Record.

1 db	2 dB	3 dB	4 dB	5 dB
6 dB	7 dB	8 dB	9 dB	10 dB
11 dB	12 dB	13 dB	14 dB	15 dB
25 dB	35 dB	45 dB	55 dB	60 dB

Repeatability Test

Use the same equipment and test setup as used in Figure 11.

The performance test can be performed at other wavelengths than 1550 nm.

1 Turn the instruments on and allow the devices to warm up (20..30min).

2 Make sure that all your connectors are clean and undamaged.

3 Set the attenuator and the power meter to the actual wavelength of the laser source.

4 Disable the laser source, zero the power meter and select Autorange. Display [dB].

5 Enable the laser source and open the shutter.

6 Set attenuation [α] to 1 dB, wait until it settles and set Display to Reference on the power meter.

7 Set the attenuation [α] to any other value (e.g. 21 dB) and wait until it settles at this value.

8 Change the attenuation [α] back to the previous value and note the deviation in the Test Record.

9 Repeat the steps 6 to 8 for the following attenuation settings:

7 dB	15 dB	24 dB	32 dB
40 dB	48 dB	54 dB	60 dB

Power Setting Repeatability Test

Use the same equipment and test setup as used in Figure 11 without the Agilent 81634B power meter. The performance test can be performed at wavelengths other than 1550 nm.

This test applies only to the Agilent 81566A and 81567A Attenuators with power control.

1 Turn the instruments on and allow the devices to warm up (20..30min).

2 Make sure that all your connectors are clean and undamaged.

3 Set the attenuator to the actual wavelength of the laser source and set the averaging time to 1s.

4 Zero the attenuator power meter, disable the power control and display [dBm].

5 Enable the laser source and open the shutter.

6 Set [P_{SET}] to 0 dBm and wait for stabilizing. Note the reading of [P_{ACT}] in the Test Record.

7 Set [P_{SET}] to any other value and wait until settling.

8 Change [P_{SET}] back to the previous value and note the deviation of [P_{ACT}] in the Test Record.

9 Repeat the steps 6 to 8 for [P_{SET}] = - 25 dBm and [P_{SET}] = - 50 dBm.

Return Loss Test

Carry out the following Return Loss Test at 1550 nm with single mode fibers using the equipment listed in Table 3, “Equipment Required,” on page 41. To adapt for the straight or angled contact versions of the attenuator use the patchcords with appropriate connectors and the adequate connector interfaces.

1 Turn the instruments on and allow the devices to warm up (20..30min).

2 Make sure that all your connectors are clean and undamaged.

3 Connect the equipment as shown below in Figure 12.

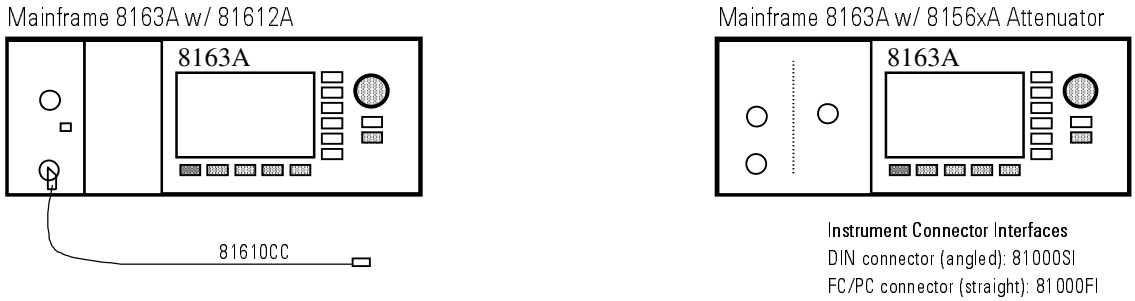


Figure 12 Return Loss Reference Setup

4 Set the attenuator and the power meter to the actual wavelength of internal laser source of the return loss meter.

5 Disable the internal laser source, cover the end of the reference cable and zero the return loss meter.

6 Uncover and clean the end of the reference cable and enable the laser source.

7 Set the reflection reference R to 14.7 dB, the default value for the return loss of the reference reflector cable 81610CC, and then select the [REF CAL] parameter.

8 The value read should now be 14.7 dB, the same as the value entered for reflection reference R.

9 Terminate the reference cable by wrapping the fiber several times around a pencil or the shaft of a screwdriver, and then select the [TERM CAL] softkey.

10 Remove the reference cable and connect the equipment as shown in Figure 13.

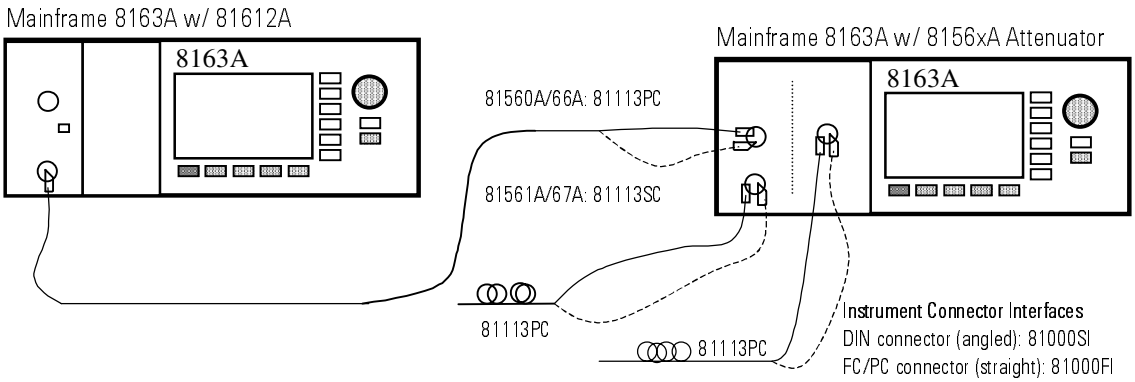


Figure 13 Return Loss Test Setup

11 Terminate the patchcord on the attenuator output by wrapping the fiber several times around a pencil or the shaft of a screwdriver. Do the same for the monitor output if applicable.

12 Set the attenuation [α] to 0 dB and note the input return loss in the Test Record.

13 Open the shutter and record the return loss in the Test Record.

14 Connect the return loss meter to the attenuator output port and terminate the input port as described in step 12.

15 You may measure the output return loss for open and closed shutter or for other arbitrary attenuation settings as described in steps 13 and 14.

Polarization Dependent Loss (PDL) Test - Scanning method

Carry out the following PDL Test at 1550 nm with single mode fibers using the equipment listed in Table 3, “Equipment Required,” on page 41. To adapt for the straight or angled contact versions of the attenuator use the patchcords with appropriate connectors and the adequate connector interfaces.

NOTE: This test method is recommended if the fiber-loop type 11869A Polarization Controller is used. If the plate-type 8169A Polarization Controller is used, refer to “Polarization Dependent Loss (PDL) Test - Mueller Method” on page 50.

1. Turn the instruments on and allow the devices to warm up (20..30 min).
2. Make sure that all your connectors are clean and undamaged.
3. Connect the equipment as shown in Figure 14

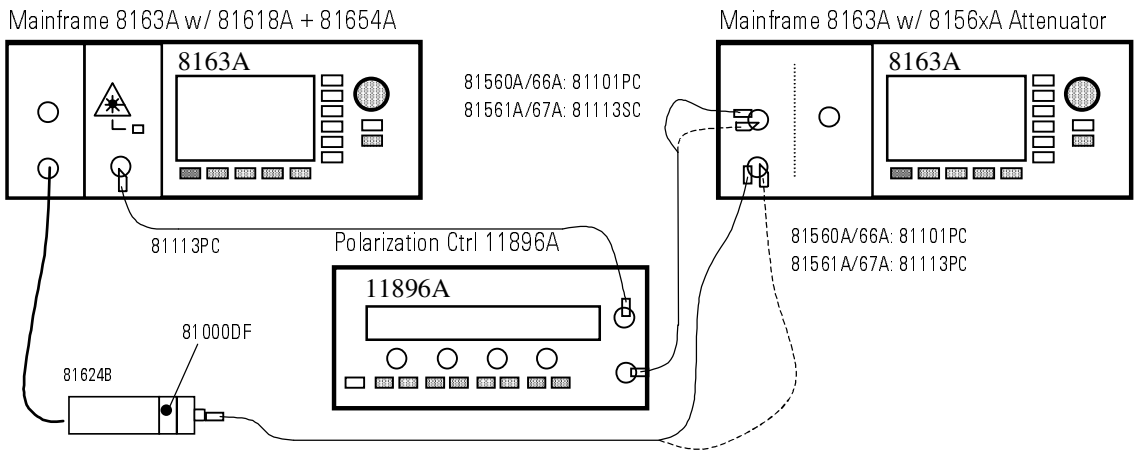


Figure 14 PDL Test Setup - Scanning Method

NOTE The patchcords from and to the polarization controller and the attenuator must not move during and between all measurements. Use tape to fix the fibers on the table.

4. Set the attenuator to the wavelength of the laser source.
5. Enable the laser source and open the shutter of the attenuator.
6. Display [dB] at the power meter and set Display to Reference.
7. Choose the power meter Stability Application and set parameters:

- Total Time = 25 seconds
- Averaging Time = 50ms

- Wavelength = Source Wavelength
- Range Mode = auto

8 Set the 11896A Polarization Controller scan rate = 4 and press [AutoScan] to start Polarization Scrambling.

9 Press Measure at the power meter to start PDL Scanning.

10 After the measurement press [Analysis] and [More] to get the power readings.

11 Note the results in the Test Record.

Polarization Dependent Loss (PDL) Test - Mueller Method

Carry out the following PDL Test at 1550 nm with single mode fibers using the equipment listed in Table 3, “Equipment Required,” on page 41. To adapt for the straight or angled contact versions of the attenuator use the patchcords with appropriate connectors and the adequate connector interfaces. Use the operation mode "Attenuation Set".

NOTE Perform this test with the plate-type 8169A Polarization Controller.

1 Turn the instruments on and allow the devices to warm up (20..30 min).

2 Make sure that all your connectors are clean and undamaged.

3 Connect the equipment as shown in Figure 15.

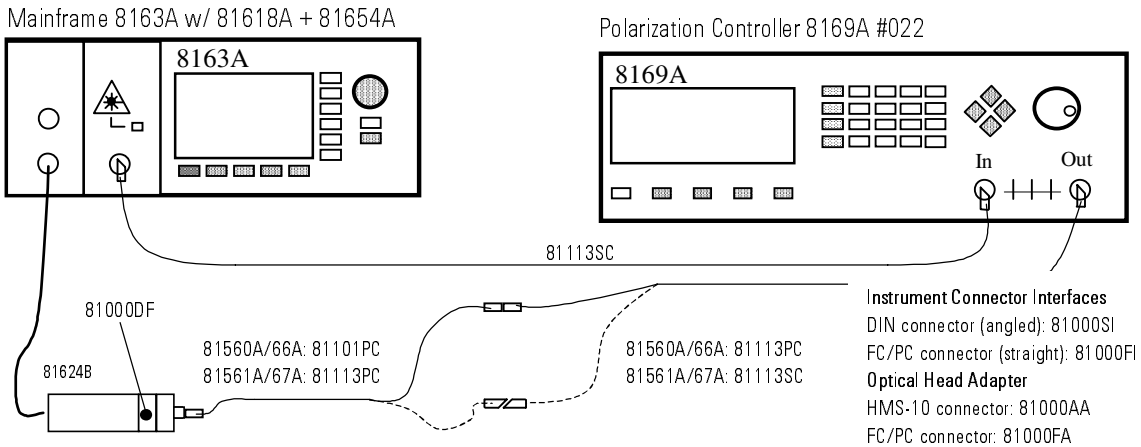


Figure 15 PDL Reference Setup

NOTE The patchcords from and to the polarization controller and the attenuator must not move during and between all measurements. Use tape to fix the fibers on the table.

4 Zero the power meter. Display [W].

5 Set the attenuator and the power meter to the actual wavelength of the source.

6 Enable the laser source and allow 5 minutes for the laser to settle.

7 Reset the polarization controller.

8 Set the polarization filter of the 8169A to maximize the signal.

9 Note the diplayed angle of the polarization filter as "Linear Horizontal Setting".

Set plates for Horizontal polarization. For the following steps the polarizer is kept constant.

10 Set the l/4 Retarder Plate to the same angle as the polarization filter.

11 Note the angle as "l/4, Linear Horizontal Polarization".

12 Set the l/2 Retarder Plate to the same angle as the polarization filter.

13 Note the angle as "l/2, Linear Horizontal Polarization".

Determine settings for Linear Vertical, Linear Diagonal and Right Hand Circular Polarization.

NOTE In order to get the required polarization, the l/2 and l/4 retarder plates need to be set to the appropriate values. The corrected positions of the polarizer plates depend on the actual wavelength and have to be taken from Table 4, “Retarder Settings,” on page 53. In the case of Linear Horizontal polarized light no correction is to be done. The table lists corrections for every 20 nm step. For wavelengths between listed values, a linear approximation should be used.

14 Get the values (possible by approximation) for the wavelength dependent offset positions for each type of polarization from Table 4, “Retarder Settings,” on page 53.

15 Add these values to those for Linear Horizontal polarized light.

16 Note the calculeted corrected wavelength dependent position values in the Test Record for the l/4 Plate setting and the l/2 Plate setting for Linear Vertical, Linear Diagonal and Right Hand Circular

Polarization.

Measure the Reference Power.

17 Keep the settings from the polarizer and the l/4 and l/2 Retarder Plates from steps 8, 10 and 12 for Linear Horizontal polarized light.

18 Note the power reading as Reference Power P1 in the Test Record.

19 Set the l/4 and l/2 Retarder Plates to the corrected wavelength dependent positions for Linear Vertical polarized light.

20 Read the power on the power meter and note is as Reference Power P2 in the Test Record.

21 Set the l/4 and l/2 Retarder Plates to the corrected wavelength dependent positions for Linear Diagonal polarized light.

22 Note the power reading as Reference Power P3 in the Test Record.

23 Set the l/4 and l/2 Retarder Plates to the corrected wavelength dependent positions for Right Hand Circular polarized light.

24 Note the power reading as Reference Power P4 in the Test Record.

25 Connect the equipment as shown in Figure 16.

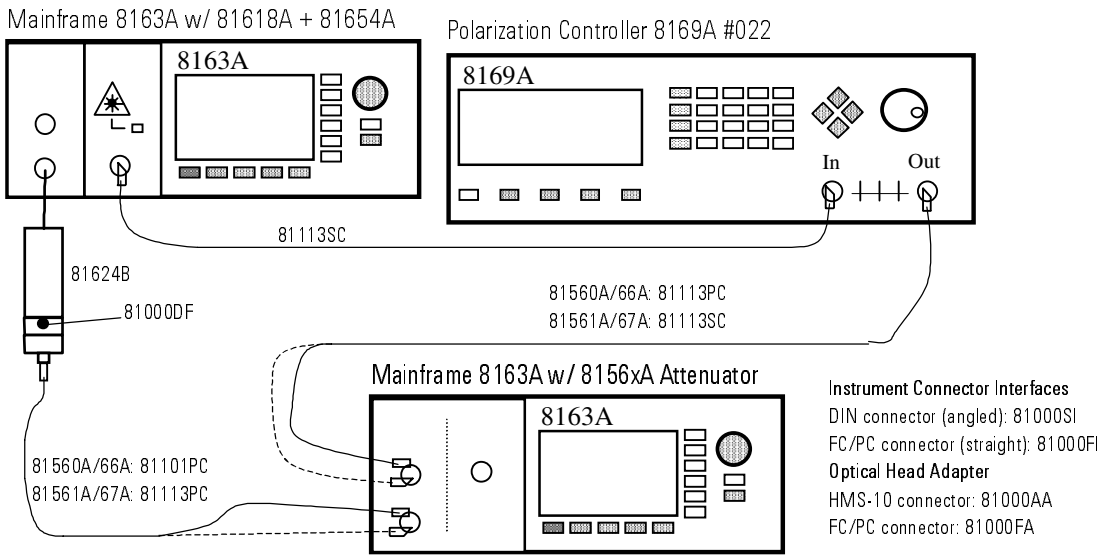


Figure 16 PDL Test Setup - Mueller Method

NOTE The patchcords from and to the polarization controller and the attenuator must not move during and between all measurements. Use tape to fix the fibers on the table.

Measure the optical power after the Attenuator Module.

26 Open the shutter of the attenuator.

27 Set the l/4 and l/2 Retarder Plates for Linear Horizontal polarized light.

28 Note the power reading as DUT Power P1 in the Test Record.

29 Set the l/4 and l/2 Retarder Plates to the corrected wavelength dependent positions for Linear Vertical polarized light.

30 Note the power that is displayed on the power meter as DUT Power P2 in the Test Record.

31 Set the l/4 and l/2 Retarder Plates to the corrected wavelength dependent positions for Linear Diagonal polarized light.

32 Note the power reading as DUT Power P3 in the Test Record.

33 Set the l/4 and l/2 Retarder Plates to the corrected wavelength dependent positions for Right Hand Circular polarized light.

34 Note the power reading as DUT Power P4 in the Test Record.

35 Calculate the Mueller coefficients, the Minimum and Maximum transmission and finally the Polarization dependent Loss (PDL) as described in the Test Record.

Table 4 Retarder Settings

λ/nm	Linear Vertical		Linear Diagonal		Right Hand Circular	
	λ/4 Plate	λ/2-Plate	λ/4-Plate	λ/2-Plate	λ/4-Plate	λ/2-Plate
1580	2.5°	46.2°	1.7°	23.3°	42.9°	-17.1°
1560	1.2°	45.6°	0.8°	22.9°	44.0°	-16.5°
1540	0°	45.0°	0°	22.5°	45.0°	-15.1°
1520	-1.4°	44.3°	-1.0°	22.0°	46.2°	-13.8°
1500	-2.7°	43.6°	-2.0°	21.4°	47.4°	-12.4°

Relative Power Meter Uncertainty Test

Carry out the following Power Meter Uncertainty Test at 1550 nm or another specified wavelength with single mode fibers using the equipment listed in Table 2: Equipment required. To adapt for the straight or angled contact versions of the attenuator use the patchcords with appropriate connectors and the adequate connector interfaces.

This test applies only to the Agilent 81566A and 815667A Attenuators with integrated power meter.

NOTE Do not turn the laser off during the measurement. Clean all connectors carefully before you start with the measurement !

1. Turn the instruments on and allow the devices to warm up (20..30 min).
2. Make sure that you perform this test in a temperature-controlled environment with temperature fluctuations less than ±1°C.
3. Make sure that all your connectors are clean and undamaged.
4. Connect the equipment as shown below in Figure 17

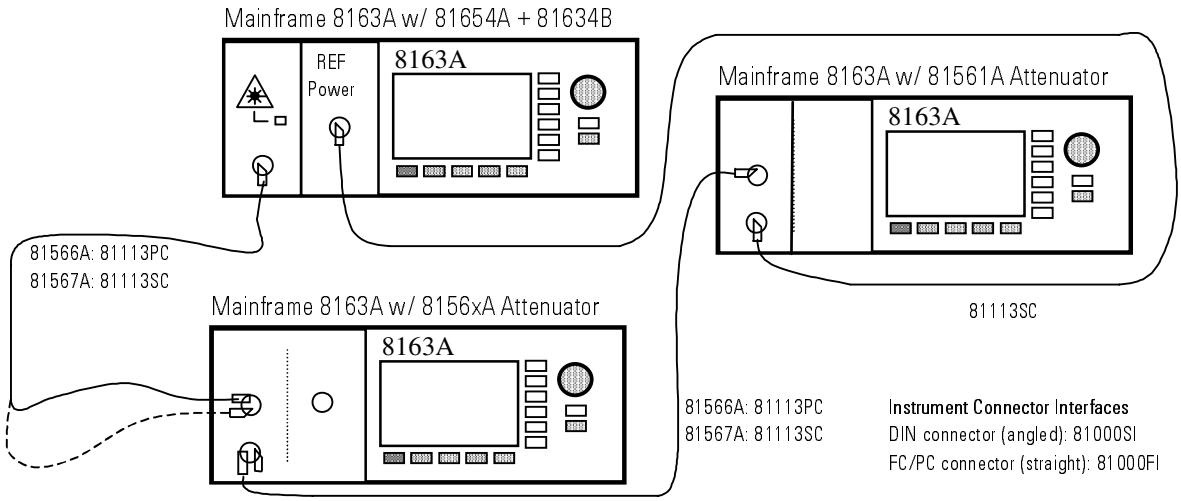


Figure 17 Relative Power Meter Uncertainty Setup

5. Set both attenuators to the wavelength of the source and disable them.
6. Set the attenuation [α] of 81561A reference attenuator to 55dB.
7. Set the attenuation [α] of the DUT attenuator to 0dB.
8. Set the averaging time of the DUT attenuator power meter to 1s.
9. Zero the reference and the attenuator power meter.

10 Enable the laser source and wait for stabilizing (>30 seconds).

11 Enable the attenuators.

12 Set the reference power meter to the wavelength of the source, set the averaging time to 1s and display [dB]. Press [Display to Reference].

13 Set the range mode of the reference power meter to [manual].

14 On the DUT attenuator edit [P Offset] until the parameter [P_{SET}] equals 0 dBm.

15 Lower [P_{SET}] and the attenuation of the reference attenuator by 5dB.

16 Note the reference power meter reading in the Test Record.

17 Repeat steps 14 and 15 until the reference attenuator shows an attenuation of 0dB.

18 Perform steps 14 and 15 upward until the reference attenuator shows 55dB.

Test Record

Agilent Optical Attenuator Module Performance Test
Page 1 of 8

Test Facility:

_____ Report No. _____

_____ Date _____

_____ Customer _____

_____ Tested By _____

Model Agilent Optical Attenuator Module Performance Test

Serial No. _____ Ambient temperature _____°C

Options _____ Relative humidity _____ %

Firmware Rev. _____ Line frequency _____ Hz

Special Notes:

_____

_____

_____

_____

_____

_____

Page 2 of 8

Agilent Optical Attentuator Module Report No. _____ Date_____

Test Equipment Used

Description	Model No.	Trace No.	Cal. Due Date
1. Mainframe	_____	_____	__/___/__
2. Power Meter	_____	_____	__/___/__
3. Laser Source	_____	_____	__/___/__
4. Return Loss Module	_____	_____	__/___/__
5. Connector Interface	_____	_____	__/___/__
6. Single Mode Fiber	_____	_____	__/___/__
7. _____	_____	_____	__/___/__
8. _____	_____	_____	__/___/__
9. _____	_____	_____	__/___/__
10. _____	_____	_____	__/___/__
11. _____	_____	_____	__/___/__
12. _____	_____	_____	__/___/__
13. _____	_____	_____	__/___/__
14. _____	_____	_____	__/___/__

Agilent Optical Attentuator Module Report No. _____ Date_____

Insertion Loss Test

Product	**81560A + 81561A**	**81566A + 81567A**
Measurement		
Supplementary Characteristic	1.7 dB	2.2 dB
Rejection Limit	> 2.2 dB	> 2.7 dB

Attenuation Accuracy Test

Setting /dB	**Reading /dB**	**Deviation /dB**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
25		
35		
45		
55		
60		
Maximum peak-to-peak Deviation		
Specification		0.2 dBpp

Agilent Optical Attenuator Module Performance Test
Page 4 of 8

Agilent Optical Attentuator Module Report No. _____ Date_____

Attenuation Repeatability Test

Setting /dB	Deviation /dB
1	
7	
15	
24	
32	
40	
48	
54	
60	
Maximum peak-to-peak Deviation	
Specification	0.02 dBpp

Power Setting Repeatability Test

Power Setting /dB	Deviation /dB
0 dBm	
-25 dBm	
-50 dBm	
Maximum peak-to-peak Deviation	
Specification	0.02 dBpp

Return Loss Test

Product	81560A + 81566A	81561A + 81567A
Attenuation Setting		
Shutter State	Open ☐ Closed ☐	Open ☐ Closed ☐
Measurement Input Port		
Measurement Output Port		
Supplementary Characteristic	> 45 dB	> 60 dB
Rejection Limit	< 42 dB	< 57 dB

Agilent Optical Attenuator Module Performance Test
Page 6 of 8

Agilent Optical Attentuator Module Report No. _____ Date_____

Polarization Dependent Loss Test - Scanning Method (11896A)

Product	81560A +81561A	81566A +81567A
Attentuation Setting		
Maximum peak-to-peak Deviation		
Specification	< 0.05 dBpp	< 0.08 dBpp

Polarization Dependent Loss Test - Mueller Method (8169A)

	Polarization			
	Linear Horizontal	**Linear Vertical**	**Linear Diagonal**	**Right Hand Circular**
Polarizer Setting	deg	n/a	n/a	n/a
λ/4 Plate Setting	deg	n/a	n/a	n/a
λ/2 Plate Setting	deg	n/a	n/a	n/a

	Corrected Wavelength Dependent Positions			
	Linear Horizontal	**Linear Vertical**	**Linear Diagonal**	**Right Hand Circular**
Polarizer Setting	n/a	deg	deg	deg
λ/4 Plate Setting	n/a	deg	deg	deg

λ/2 Plate Setting	n/a	deg	deg	deg

Measurement	**P_1**	**P_2**	**P_3**	**P_4**
Reference Power	µW	µW	µW	µW
DUT Power	µW	µW	µW	µW

Mueller Coefficients				
m_{11}	=	$(P_{DUT1} / P_{REF1} + P_{DUT2} / P_{REF2})/2$	=	
m_{12}	=	$(P_{DUT1} / P_{REF1} - P_{DUT2} / P_{REF2})/2$	=	
m_{13}	=	$(P_{DUT3} / P_{REF3}) - m_{11}$	=	
m_{14}	=	$(P_{DUT4} / P_{REF4}) - m_{11}$	=	
Minimum and Maximum Transmission				
T_{max}	=	$m_{11} + \sqrt{m_{12}^2 + m_{13}^2 + m_{14}^2}$	=	
T_{max}	=	$m_{11} - \sqrt{m_{12}^2 + m_{13}^2 + m_{14}^2}$	=	

Product	**81560A + 81561A**	**81566A + 81567A**
Polarization Dependent Loss PDL = 10 lg (Tmax / Tmin) dBpp		
Specification	< 0.05 dBpp	< 0.08 dBpp

Agilent Optical Attenuator Module Performance Test
Page 8 of 8

Agilent Optical Attentuator Module Report No. _____ Date_____

Relative Power Meter Uncertainty Test

8156xA [PSET] /dBm	Reference Attenuation /dB	Reference Reading 1 /dB	Reference Reading 2 /dB
0	55	0	
-5	50		
-10	45		
-15	40		
-20	35		
-25	30		
-30	25		
-35	20		
-40	15		
-45	10		
-50	5		
-55	0		
Maximum peak-to-peak deviation			
Specification		**0.06 dBpp**	

Cleaning Information

The following Cleaning Information contains some general safety precautions, which must be observed during all phases of cleaning. Consult your specific optical device manuals or guides for full information on safety matters.

Please try, whenever possible, to use physically contacting connectors, and dry connections. Clean the connectors, interfaces, and bushings carefully after use.

If you are unsure of the correct cleaning procedure for your optical device, we recommend that you first try cleaning a dummy or test device.

Agilent Technologies assume no liability for the customer's failure to comply with these requirements.

Cleaning Instructions for this Instrument

This Cleaning Information applies to a number of different types of Optical Equipment.

"How to clean instruments with a physical contact interface" on page 79 is particularly relevant to this module.

Safety Precautions

Please follow the following safety rules:

- Do not remove instrument covers when operating.
- Ensure that the instrument is switched off throughout the cleaning procedures.
- Use of controls or adjustments or performance of procedures other than those specified may result in hazardous radiation exposure.
- Make sure that you disable all sources when you are cleaning any optical interfaces.
- Under no circumstances look into the end of an optical device attached to optical outputs when the device is operational. The laser radiation is not visible to the human eye, but it can seriously damage your eyesight.
- To prevent electrical shock, disconnect the instrument from the mains before cleaning. Use a dry cloth, or one slightly dampened with water, to clean the external case parts. Do not attempt to clean internally.
- Do not install parts or perform any unauthorized modification to optical devices.
- Refer servicing only to qualified and authorized personnel.

Why is it important to clean optical devices?

In transmission links optical fiber cores are about 9 µm (0.00035") in diameter. Dust and other particles, however, can range from tenths to hundredths of microns in diameter. Their comparative size means that they can cover a part of the end of a fiber core, and as a result will reduce the performance of your system.

Furthermore, the power density may burn dust into the fiber and cause additional damage (for example, 0 dBm optical power in a single mode fiber causes a power density of approximately 16 million W/m^2). If this happens, measurements become inaccurate and non-repeatable.

Cleaning is, therefore, an essential yet difficult task. Unfortunately, when comparing most published cleaning recommendations, you will discover that they contain several inconsistencies. In this section, we want to suggest ways to help you clean your various optical devices, and thus significantly improve the accuracy and repeatability of your lightwave measurements.

What do I need for proper cleaning?

Some Standard Cleaning Equipment is necessary for cleaning your instrument. For certain cleaning procedures, you may also require certain Additional Cleaning Equipment.

Standard Cleaning Equipment

Before you can start your cleaning procedure you need the following standard equipment:

- Dust and shutter caps
- Isopropyl alcohol
- Cotton swabs
- Soft tissues
- Pipe cleaner
- Compressed air

Dust and shutter caps

All of Agilent Technologies' lightwave instruments are delivered with either laser shutter caps or dust caps on the lightwave adapter. Any cables come with covers to protect the cable ends from damage or contamination.

We suggest these protective coverings should be kept on the equipment at all times, except when your optical device is in use. Be careful when replacing dust caps after use. Do not press the bottom of the cap onto the fiber too hard, as any dust in the cap can scratch or pollute your fiber surface.

If you need further dust caps, please contact your nearest Agilent Technologies sales office.

Isopropyl alcohol

This solvent is usually available from any local pharmaceutical supplier or chemist's shop.

If you use isopropyl alcohol to clean your optical device, do not immediately dry the surface with compressed air (except when you are cleaning very sensitive optical devices). This is because the dust and the dirt is solved and will leave behind filmy deposits after the alcohol is evaporated. You should therefore first remove the alcohol and the dust with a soft tissue, and then use compressed air to blow away any remaining filaments.

If possible avoid using denatured alcohol containing additives. Instead, apply alcohol used for medical purposes.

Never drink this alcohol, as it may seriously damage to your health.

Do not use any other solvents, as some may damage plastic materials and claddings. Acetone, for example, will dissolve the epoxy used with fiber optic connectors. To avoid damage, only use isopropyl alcohol.

Cotton swabs

We recommend that you use swabs such as Q-tips or other cotton swabs normally available from local distributors of medical and hygiene products (for example, a supermarket or a chemist's shop). You may be able to obtain various sizes of swab. If this is the case, select the smallest size for your smallest devices.

Ensure that you use natural cotton swabs. Foam swabs will often leave behind filmy deposits after cleaning.

Use care when cleaning, and avoid pressing too hard onto your optical device with the swab. Too much pressure may scratch the surface, and could cause your device to become misaligned. It is advisable to rub gently over the surface using only a small circular movement.

Swabs should be used straight out of the packet, and never used twice. This is because dust and dirt in the atmosphere, or from a first cleaning, may collect on your swab and scratch the surface of your optical device.

Soft tissues

These are available from most stores and distributors of medical and hygiene products such as supermarkets or chemists' shops.

We recommend that you do not use normal cotton tissues, but multi-layered soft tissues made from non-recycled cellulose. Cellulose tissues are very absorbent and softer. Consequently, they will not scratch the surface of your device over time.

Use care when cleaning, and avoid pressing on your optical device with the tissue. Pressing too hard may lead to scratches on the surface or misalignment of your device. Just rub gently over the surface using a small circular movement.

Use only clean, fresh soft tissues and never apply them twice. Any dust and dirt from the air which collects on your tissue, or which has gathered after initial cleaning, may scratch and pollute your optical device.

Pipe cleaner

Pipe cleaners can be purchased from tobacconists, and come in various shapes and sizes.The most suitable one to select for cleaning purposes has soft bristles, which will not produces scratches.

There are many different kinds of pipe cleaner available from tobacco nists.

The best way to use a pipe cleaner is to push it in and out of the device opening (for example, when cleaning an interface). While you are cleaning, you should slowly rotate the pipe cleaner.

Only use pipe cleaners on connector interfaces or on feed through adapters. Do not use them on optical head adapters, as the center of a pipe cleaner is hard metal and can damage the bottom of the adapter.

Your pipe cleaner should be new when you use it. If it has collected any dust or dirt, this can scratch or contaminate your device.

The tip and center of the pipe cleaner are made of metal. Avoid accidentally pressing these metal parts against the inside of the device, as this can cause scratches.

Compressed air

Compressed air can be purchased from any laboratory supplier.

It is essential that your compressed air is free of dust, water and oil. Only use clean, dry air. If not, this can lead to filmy deposits or scratches on the surface of your connector. This will reduce the performance of your transmission system.

When spraying compressed air, hold the can upright. If the can is held at a slant, propellant could escape and dirty your optical device. First spray into the air, as the initial stream of compressed air could contain some condensation or propellant. Such condensation leaves behind a filmy deposit.

Please be friendly to your environment and use a CFC-free aerosol.

Additional Cleaning Equipment

Some Cleaning Procedures need the following equipment, which is not required to clean each instrument:

- Microscope with a magnification range about 50X up to 300X
- Ultrasonic bath
- Warm water and liquid soap
- Premoistened cleaning wipes
- Polymer film
- Infrared Sensor Card

Microscope with a magnification range about 50X up to 300X

A microscope can be found in most photography stores, or can be obtained through or specialist mail order companies. Special fiber-scopes are available from suppliers of splicing equipment.

Ideally, the light source on your microscope should be very flexible. This will allow you to examine your device closely and from different angles.

A microscope helps you to estimate the type and degree of dirt on your device. You can use a microscope to choose an appropriate cleaning method, and then to examine the results. You can also use your microscope to judge whether your optical device (such as a connector) is severely scratched and is, therefore, causing inaccurate measurements.

Ultrasonic bath

Ultrasonic baths are also available from photography or laboratory suppliers or specialist mail order companies.

An ultrasonic bath will gently remove fat and other stubborn dirt from your optical devices. This helps increase the life span of the optical devices.

Only use isopropyl alcohol in your ultrasonic bath, as other solvents may cause damage.

Warm water and liquid soap

Only use water if you are sure that there is no other way of cleaning your optical device without causing corrosion or damage. Do not use hot water, as this may cause mechanical stress, which can damage your optical device.

Ensure that your liquid soap has no abrasive properties or perfume in it. You should also avoid normal washing up liquid, as it can cover your device in an iridescent film after it has been air dried.

Some lenses and mirrors also have a special coating, which may be sensitive to mechanical stress, or to fat and liquids. For this reason we recommend you do not touch them.

If you are not sure how sensitive your device is to cleaning, please contact the manufacturer or your sales distributor.

Premoistened cleaning wipes

Use pre-moistened cleaning wipes as described in each individual cleaning procedure. Cleaning wipes may be used in every instance where a moistened soft tissue or cotton swab is applied.

Polymer film

Polymer film is available from laboratory suppliers or specialist mail order companies.

Using polymer film is a gentle method of cleaning extremely sensitive devices, such as reference reflectors and mirrors.

Infrared Sensor Card

Infrared sensor cards are available from laboratory suppliers or specialist mail order companies.

With this card you are able to control the shape of laser light emitted. The invisible laser beam is projected onto the sensor card, then becomes visible to the normal eye as a round spot.

Take care never to look into the end of a fiber or any other optical component, when they are in use. This is because the laser can seriously damage your eyes.

Preserving Connectors

Listed below are some hints on how best to keep your connectors in the best possible condition.

Making Connections

Before you make any connection you must ensure that all cables and connectors are clean. If they are dirty, use the appropriate cleaning procedure.

When inserting the ferrule of a patchcord into a connector or an adapter, make sure that the fiber end does not touch the outside of the mating connector or adapter. Otherwise you will rub the fiber end against an unsuitable surface, producing scratches and dirt deposits on the surface of your fiber.

Dust Caps and Shutter Caps

Be careful when replacing dust caps after use. Do not press the bottom of the cap onto the fiber as any dust in the cap can scratch or dirty your fiber surface.

When you have finished cleaning, put the dust cap back on, or close the shutter cap if the equipment is not going to be used immediately.

Always keep the caps on the equipment when it is not in use.

All of Agilent Technologies' lightwave instruments and accessories are shipped with either laser shutter caps or dust caps. If you need additional or replacement dust caps, contact your nearest Agilent Technologies Sales/Service Office.

Immersion Oil and Other Index Matching Compounds

Wherever possible, do not use immersion oil or other index matching compounds with your device. They are liable to impair and dirty the surface of the device. In addition, the characteristics of your device can be changed and your measurement results affected.

Cleaning Instrument Housings

Use a dry and very soft cotton tissue to clean the instrument housing and the keypad. Do not open the instruments as there is a danger of electric shock, or electrostatic discharge. Opening the instrument can cause damage to sensitive components, and in addition your warranty will be voided.

Which Cleaning Procedure should I use ?

Light dirt

If you just want to clean away light dirt, observe the following procedure for all devices:

- Use compressed air to blow away large particles.
- Clean the device with a dry cotton swab.
- Use compressed air to blow away any remaining filament left by the swab.

Heavy dirt

If the above procedure is not enough to clean your instrument, follow one of the procedures below. Please consult *"Cleaning Instructions for this Instrument" on page 66* for the procedure relevant for this instrument.

If you are unsure of how sensitive your device is to cleaning, please contact the manufacturer or your sales distributor

How to clean connectors

Cleaning connectors is difficult as the core diameter of a single-mode fiber is only about 9 µm. This generally means you cannot see streaks or scratches on the surface. To be certain of the condition of the surface of your connector and to check it after cleaning, you need a microscope.

In the case of scratches, or of dust that has been burnt onto the surface of the connector, you may have no option but to polish the connector. This depends on the degree of dirtiness, or the depth of the scratches. This is a difficult procedure and should only be performed by a skilled person, and as a last resort as it wears out your connector.

WARNING

Never look into the end of an optical cable that is connected to an active source.

To assess the projection of the emitted light beam you can use an infrared sensor card. Hold the card approximately 5 cm from the output of the connector. The invisible emitted light is projected onto the card and becomes visible as a small circular spot.

Preferred Procedure

Use the following procedure on most occasions.

1. Clean the connector by rubbing a new, dry cotton swab over the surface using a small circular movement.
2. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure when there is greasy dirt on the connector:

1. Moisten a new cotton swab with isopropyl alcohol.
2. Clean the connector by rubbing the cotton swab over the surface using a small circular movement.
3. Take a new, dry soft tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4. Blow away any remaining lint with compressed air.

An Alternative Procedure

A better, more gentle, but more expensive cleaning procedure is to use an ultrasonic bath with isopropyl alcohol.

1. Hold the tip of the connector in the bath for at least three minutes.
2. Take a new, dry soft tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
3. Blow away any remaining lint with compressed air.

How to clean connector adapters

CAUTION

Some adapters have an anti-reflection coating on the back to reduce back reflection. This coating is extremely sensitive to solvents and mechanical abrasion. Extra care is needed when cleaning these adapters.

Preferred Procedure

Use the following procedure on most occasions.

1. Clean the adapter by rubbing a new, dry cotton swab over the surface using a small circular movement.
2. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure when there is greasy dirt on the adapter:

1. Moisten a new cotton swab with isopropyl alcohol.
2. Clean the adapter by rubbing the cotton swab over the surface using a small circular movement.
3. Take a new, dry soft tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4. Blow away any remaining lint with compressed air.

How to clean connector interfaces

CAUTION

Be careful when using pipe cleaners, as the core and the bristles of the pipe cleaner are hard and can damage the interface.

Do not use pipe cleaners on optical head adapters, as the hard core of normal pipe cleaners can damage the bottom of an adapter.

Preferred Procedure

Use the following procedure on most occasions.

1. Clean the interface by pushing and pulling a new, dry pipe cleaner into the opening. Rotate the pipe cleaner slowly as you do this.
2. Then clean the interface by rubbing a new, dry cotton swab over the surface using a small circular movement.
3. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure when there is greasy dirt on the interface:

1. Moisten a new pipe cleaner with isopropyl alcohol.
2. Clean the interface by pushing and pulling the pipe cleaner into the opening. Rotate the pipe cleaner slowly as you do this.

3 Moisten a new cotton swab with isopropyl alcohol.

4 Clean the interface by rubbing the cotton swab over the surface using a small circular movement.

5 Using a new, dry pipe cleaner, and a new, dry cotton swab remove the alcohol, any dissolved sediment and dust.

6 Blow away any remaining lint with compressed air.

How to clean bare fiber adapters

Bare fiber adapters are difficult to clean. Protect from dust unless they are in use.

CAUTION

Never use any kind of solvent when cleaning a bare fiber adapter as solvents can:

- Damage the foam inside some adapters.
- Deposit dissolved dirt in the groove, which can then dirty the surface of an inserted fiber.

Preferred Procedure

Use the following procedure on most occasions.

1 Blow away any dust or dirt with compressed air.

Procedure for Stubborn Dirt

Use this procedure when there is greasy dirt on the adapter:

1 Clean the adapter by pushing and pulling a new, dry pipe cleaner into the opening. Rotate the pipe cleaner slowly as you do this.

CAUTION

Be careful when using pipe cleaners, as the core and the bristles of the pipe cleaner are hard and can damage the adapter.

2 Clean the adapter by rubbing a new, dry cotton swab over the surface using a small circular movement.

3 Blow away any remaining lint with compressed air.

How to clean lenses

Some lenses have special coatings that are sensitive to solvents, grease, liquid and mechanical abrasion. Take extra care when cleaning lenses with these coatings.

Lens assemblies consisting of several lenses are not normally sealed. Therefore, use as little alcohol as possible, as it can get between the lenses and in doing so can change the properties of projection.

Preferred Procedure

Use the following procedure on most occasions.

1. Clean the lens by rubbing a new, dry cotton swab over the surface using a small circular movement.
2. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure when there is greasy dirt on the lens:

1. Moisten a new cotton swab with isopropyl alcohol.
2. Clean the lens by rubbing the cotton swab over the surface using a small circular movement.
3. Using a new, dry cotton swab remove the alcohol, any dissolved sediment and dust.
4. Blow away any remaining lint with compressed air.

How to clean instruments with a fixed connector interface

You should only clean instruments with a fixed connector interface when it is absolutely necessary. This is because it is difficult to remove any used alcohol or filaments from the input of the optical block.

It is important, therefore, to keep dust caps on the equipment at all times, except when your optical device is in use.

If you do discover filaments or particles, the only way to clean a fixed connector interface and the input of the optical block is to use compressed air.

If there are fluids or fat in the connector, please refer the instrument to the skilled personnel of Agilent's service team.

CAUTION

Only use clean, dry compressed air. Make sure that the air is free of dust, water, and oil. If the air that you use is not clean and dry, this can lead to filmy deposits or scratches on the surface of your connector interface. This will degrade the performance of your transmission system.

Never try to open the instrument and clean the optical block by yourself, because it is easy to scratch optical components, and cause them to become misaligned.

How to clean instruments with an optical glass plate

Some instruments, for example, the optical heads from Agilent Technologies have an optical glass plate to protect the sensor. Clean this glass plate in the same way as optical lenses (see *"How to clean lenses" on page 78*).

How to clean instruments with a physical contact interface

Remove any connector interfaces from the optical output of the instrument before you begin the cleaning procedure.

Cleaning interfaces is difficult as the core diameter of a single-mode fiber is only about 9 µm. This generally means you cannot see streaks or scratches on the surface. To be certain of the degree of pollution on the surface of your interface and to check whether it has been removed after cleaning, you need a microscope.

WARNING

Never look into an optical output, because this can seriously damage your eyesight.

To assess the projection of the emitted light beam you can use an infrared sensor card. Hold the card approximately 5 cm from the interface. The invisible emitted light is projected onto the card and becomes visible as a small circular spot.

Preferred Procedure

Use the following procedure on most occasions.

1. Clean the interface by rubbing a new, dry cotton swab over the surface using a small circular movement.
2. Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure when there is greasy dirt on the interface:

1. Moisten a new cotton swab with isopropyl alcohol.
2. Clean the interface by rubbing the cotton swab over the surface using a small circular movement.
3. Take a new, dry soft tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.
4. Blow away any remaining lint with compressed air.

How to clean instruments with a recessed lens interface

WARNING

For instruments with a deeply recessed lens interface (for example the Agilent 81633A and 81634A Power Sensors) do NOT follow this procedure. Alcohol and compressed air could damage your lens even further.

Keep your dust and shutter caps on when your instrument is not in use. This should prevent it from getting too dirty. If you must clean such instruments, please refer the instrument to the skilled personnel of Agilent's service team.

Preferred Procedure

Use the following procedure on most occasions.

1 Blow away any dust or dirt with compressed air.
If this is not sufficient, then

2 Clean the interface by rubbing a new, dry cotton swab over the surface using a small circular movement.

3 Blow away any remaining lint with compressed air.

Procedure for Stubborn Dirt

Use this procedure when there is greasy dirt on the interface, and using the preferred procedure is not sufficient. Using isopropyl alcohol should be your last choice for recessed lens interfaces because of the difficulty of cleaning out any dirt that is washed to the edge of the interface:

1 Moisten a new cotton swab with isopropyl alcohol.

2 Clean the interface by rubbing the cotton swab over the surface using a small circular movement.

3 Take a new, dry soft tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.

4 Blow away any remaining lint with compressed air.

How to clean optical devices which are sensitive to mechanical stress and pressure

Some optical devices, such as the Agilent 81000BR Reference Reflector, which has a gold plated surface, are very sensitive to mechanical stress or pressure. Do not use cotton swabs, soft tissues or other mechanical cleaning tools, as these can scratch or destroy the surface.

Preferred Procedure

Use the following procedure on most occasions.

1 Blow away any dust or dirt with compressed air.

Procedure for Stubborn Dirt

To clean devices that are extremely sensitive to mechanical stress or pressure you can also use an optical clean polymer film. This

procedure is time-consuming, but you avoid scratching or destroying the surface.

1 Put the film on the surface and wait at least 30 minutes to make sure that the film has had enough time to dry.

2 Remove the film and any dirt with special adhesive tapes.

Alternative Procedure

For these types of optical devices you can often use an ultrasonic bath with isopropyl alcohol. Only use the ultrasonic bath if you are sure that it won't cause any damage any part of the device.

1 Put the device into the bath for at least three minutes.

2 Blow away any remaining liquid with compressed air.

If there are any streaks or drying stains on the surface, repeat the cleaning procedure.

How to clean metal filters or attenuator gratings

This kind of device is extremely fragile. A misalignment of the grating leads to inaccurate measurements. Never touch the surface of the metal filter or attenuator grating. Be very careful when using or cleaning these devices. Do not use cotton swabs or soft tissues, as there is the danger that you cannot remove the lint and that the device will be destroyed by becoming mechanically distorted.

Preferred Procedure

Use the following procedure on most occasions.

1 Use compressed air at a distance and with low pressure to remove any dust or lint.

Procedure for Stubborn Dirt

Do not use an ultrasonic bath as this can damage your device.

Use this procedure when there is greasy dirt on the device:

1 Put the optical device into a bath of isopropyl alcohol, and wait at least 10 minutes.

2 Remove the fluid using compressed air at some distance and with low pressure. If there are any streaks or drying stains on the surface, repeat the whole cleaning procedure.

Additional Cleaning Information

The following cleaning procedures may be used with other optical equipment:

- How to clean bare fiber ends
- How to clean large area lenses and mirrors

How to clean bare fiber ends

Bare fiber ends are often used for splices or, together with other optical components, to create a parallel beam. The end of a fiber can often be scratched. You make a new cleave. To do this:

1 Strip off the cladding.

2 Take a new soft tissue and moisten it with isopropyl alcohol.

3 Carefully clean the bare fiber with this tissue.

4 Make your cleave and immediately insert the fiber into your bare fiber adapter in order to protect the surface from dirt.

How to clean large area lenses and mirrors

Some mirrors, as those from a monochromator, are very soft and sensitive. Therefore, never touch them and do not use cleaning tools such as compressed air or polymer film.

Some lenses have special coatings that are sensitive to solvents, grease, liquid and mechanical abrasion. Take extra care when cleaning lenses with these coatings.

Lens assemblies consisting of several lenses are not normally sealed. Therefore, use as little liquid as possible, as it can get between the lenses and in doing so can change the properties of projection.

Preferred Procedure

Use the following procedure on most occasions.

1 Blow away any dust or dirt with compressed air.

Procedure for Stubborn Dirt

Use this procedure when there is greasy dirt on the lens:

CAUTION

Only use water if you are sure that there is no other way of cleaning your optical device without causing corrosion or damage.

Only use water if you are sure that there is no other way of cleaning your optical device without causing corrosion or damage. Do not use hot water, as this may cause mechanical stress, which can damage your optical device.

Ensure that your liquid soap has no abrasive properties or perfume in it. You should also avoid normal washing up liquid, as it can cover your device in an iridescent film after it has been air dried.

Some lenses and mirrors also have a special coating, which may be sensitive to mechanical stress, or to fat and liquids. For this reason we recommend you do not touch them.

If you are not sure how sensitive your device is to cleaning, please contact the manufacturer or your sales distributor.

1 Moisten the lens or the mirror with water.

2 Put a little liquid soap on the surface and gently spread the liquid over the whole area.

3 Wash off the emulsion with water, being careful to remove it all, as any remaining streaks can impair measurement accuracy.

4 Take a new, dry soft tissue and remove the water, by rubbing gently over the surface using a small circular movement.

5 Blow away remaining lint with compressed air.

Alternative Procedure A

To clean lenses that are extremely sensitive to mechanical stress or pressure you can also use an optical clean polymer film. This procedure is time-consuming, but you avoid scratching or destroying the surface.

1 Put the film on the surface and wait at least 30 minutes to make sure that the film has had enough time to dry.

2 Remove the film and any dirt with special adhesive tapes.

Alternative Procedure B

If your lens is sensitive to water then:

1 Moisten the lens or the mirror with isopropyl alcohol.

2 Take a new, dry soft tissue and remove the alcohol, dissolved sediment and dust, by rubbing gently over the surface using a small circular movement.

3 Blow away remaining lint with compressed air.

Other Cleaning Hints

Selecting the correct cleaning method is an important element in maintaining your equipment and saving you time and money. This Appendix highlights the main cleaning methods, but cannot address every individual circumstance.

This section contain some additional hints which we hope will help you further. For further information, please contact your local Agilent Technologies representative.

Making the connection

Before you make any connection you must ensure that all lightwave cables and connectors are clean. If not, then use the appropriate cleaning methods.

When you insert the ferrule of a patchcord into a connector or an adapter, ensure that the fiber end does not touch the outside of the mating connector or adapter. Otherwise, the fiber end will rub up against something which could scratch it and leave deposits.

Lens cleaning papers

Some special lens cleaning papers are not suitable for cleaning optical devices like connectors, interfaces, lenses, mirrors and so on. To be absolutely certain that a cleaning paper is applicable, please ask the salesperson or the manufacturer.

Immersion oil and other index matching compounds

Do not use immersion oil or other index matching compounds with optical sensors equipped with recessed lenses. They are liable to dirty the detector and impair its performance. They may also alter the property of depiction of your optical device, thus rendering your measurements inaccurate.

Cleaning the housing and the mainframe

When cleaning either the mainframe or the housing of your instrument, only use a dry and very soft cotton tissue on the surfaces and the numeric pad.

Never open the instruments as they can be damaged. Opening the instruments puts you in danger of receiving an electrical shock from your device, and renders your warranty void.

Index

A

Attenuator 17

C

Cleaning 65

Connectors
  angled contact 22, 28
  straight contact 22

Conventions 7

D

Definition of Terms 31
  Absolute Wavelength Accuracy 32

F

Front Panel
  Agilent 81689A 18, 19
  Agilent 81689B 18, 19
  Controls and Indicators 18, 19

G

Getting Started 15

I

Inspection 3

L

Line Power 4

O

Optical Output 22

Optional features 25

P

Performance Tests 40
  Instructions 43

Polarization Maintaining Fiber 22

S

Safety
  symbols 3

U

Use Models 20

User's Guides 26

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